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Testing the absorber hypothesis of exchange rates for the overshooting of agricultural prices in China

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Abstract: This study aims to test the overshooting effect of agricultural prices and the absorber hypothesis of exchange rates by extending the existing overshooting model. Using a combination of modern time series methods and monthly aggregate data from China, we demonstrate that overshooting of agricultural prices does indeed occur since the impact of monetary expansion on flexible agricultural prices is significantly larger than on relatively sticky industrial prices. Granger causality tests confirm that monetary expansion is a possible determinant of the movements of both agricultural and industrial prices, thus providing a solid empirical foundation for the overshooting hypothesis. Our findings also confirm the absorber hypothesis, in that the overshooting effect of agricultural prices under a fixed exchange rate regime (ERR) is shown to be greater than that under a floating ERR. The main policy implication is that policymakers should pay attention to the spillover effect of monetary expansion on agricultural prices when adjusting macroeconomic policies, especially under a fixed ERR.

Keywords: cointegration; floating exchange rates; monetary policy; vector autoregression

The overshooting of agricultural prices is a common phenomenon, as shown in many previous studies (Lee 2016). According to the theory of money neutrality, the prices of all sectors in an economy will respond uniformly to a monetary expansion shock. That is, a variation in money supply will not change relative prices between different sectors, which are subject to relationships between real product demand and supply (Belongia and King 1983). However, as documented in the literature and observed worldwide, monetary shocks not only affect the nominal prices of commodities in all sectors but also change their relative levels. This is the so-called overshooting effect, which has been widely tested by several studies (Saghaian et al. 2002a, 2002b; Asfaha and Jooste 2007; Bakucs et al. 2012; Alam et al. 2017).

Nonetheless, almost all overshooting models are based on the underlying assumption that exchange rates are flexible and determined by the money supply. Theoretically, the exchange rates in these models are embedded as 'absorbers', which dampen the overshooting effect on commodity prices resulting from monetary expansion (Kwon and Koo 2009). However, this assumption is unrealistic for some developing economies, in which fixed exchange rate regimes (ERRs) have prevailed while their economies were growing or during transitional periods. For instance, China maintained a fixed exchange rate, pegged to the US dollar, until July 2005, after which a floating ERR was enforced (see Figure 1 for China's recent exchange rate movements). According to overshooting theory, the monetary expansion shock should have been totally

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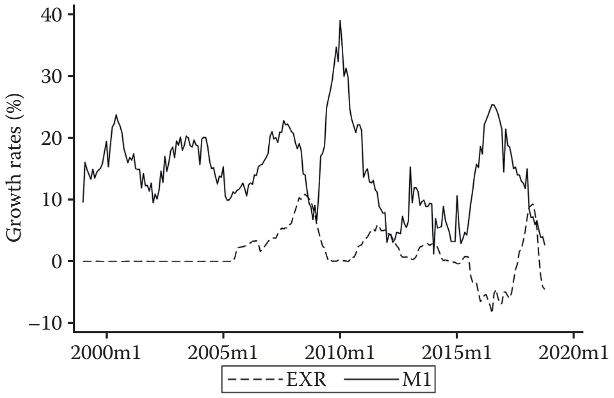

Figure 1. The fluctuation of exchange rates and M1 growth rate

M1, m1, and EXR – the money supply growth rate, the first month (i.e. January) in each year, and exchange rates, respectively
Source: Wind Economic Database (Wind 2020)

absorbed by the flexible-price sectors (e.g. agriculture) under the fixed ERR before 2005. Whereas after the reform, floating exchange rates could have absorbed part of the shock induced by the monetary expansion and correspondingly, the degree of overshooting of agricultural prices would have lessened. In other words, if the absorber effect indeed exists, neglecting the differences between the fixed and floating exchange rates would probably lead to biased, or even incorrect, conclusions.

The main purpose of this study is to test the reliability of the absorber hypothesis of exchange rates by comparing the overshooting mechanisms of agricultural prices under two different ERRs. Both theoretical and policy implications are presented as follows. First, the study extends the overshooting model developed by Saghaian et al. (2002b) by relaxing the absolute stickiness of industrial prices and providing a new perspective for the relationship between ERR and the overshooting of prices; it also highlights the role of exchange rates in reflecting the overshooting mechanism of agricultural prices. Second, it tests and verifies the absorber hypothesis of exchange rates, using a time series approach with monthly data. The empirical results are insightful for both academic researchers and policymakers, especially those policymakers in developing economies attempting to reform their ERR and avoid sharp fluctuations in commodity prices.

Testing the overshooting hypothesis has been one of the most important topics in economics research for nearly half a century. Research in this area began with Dornbusch (1976), who investigated the dynamics of flexible exchange rates and the response of sticky commodity prices to monetary expansion and identified the overshooting effect of exchange rates on commodity prices. Subsequently, the overshooting hypothesis of exchange rates became a hot topic in macroeconomics and international economics research (Bordo 1980; Starleaf et al. 1985; Devadoss and Meyers 1987; Choe and Koo 1993; Isaac 1998). As the overshooting of exchange rates is not the main focus of this study, we refer readers to Heinlein and Krolzig (2012) and Lee (2016) for detailed reviews.

At almost the same time Dornbusch (1976) formulated his overshooting hypothesis, the relationship between the macroeconomy and agricultural prices was formally investigated (Schuh 1974). Through the development and wide application of Dornbusch's (1976) overshooting theory, agricultural economists began to consider building an overshooting framework to analyse the movement of agricultural prices. Specifically, Frankel (1986) developed an overshooting model to investigate the dynamic relationship between agricultural and industrial prices under the shock of a monetary expansion. Stamoulis and Rausser (1987) extended the model to an open economy and found that the movements of exchange rates and agricultural prices were synchronised. Lai et al. (1996) relaxed some assumptions of the model and asserted that industrial prices could be an important determinant of monetary policy. Saghaian et al. (2002b) expanded the overshooting model to incorporate three sectors and obtained similar empirical findings as those of Frankel (1986). Lai et al. (2005) further relaxed the assumptions of Frankel (1986) and considered that the overshooting of agricultural prices would differ by the degree of bond substitution. When the money supply is large and bond substitutability high, agricultural prices adjust to reach an excessively high level. Saghaian et al. (2006) focused on the specific agricultural products and found that the downstream livestock prices overshot more than the upstream grain prices since the latter were less traded internationally. Saghaian and Reed (2014) investigated the impacts of the Federal Reserve's purchases of long-term assets on the fluctuations of agricultural prices. They found that the effects differed by commodity due to the diverse supply-demand situation, production process, and storability. Further, Lee (2016) added to the model the parameter of external assets flowing into the country, ultimately optimising the overshooting model by emphasising the role of foreign exchange reserves. A larger domestic foreign exchange reserve means that the overshooting of exchange rates is significantly greater than that

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occurring in Dornbusch's (1976) setting. Subsequently, using a factor-augmented vector autoregressive model, Alam and Gilbert (2017) examined the effects of monetary policy, global economic conditions, and US dollar exchange rates on agricultural commodity prices. Using an autoregressive moving average with an exponential generalised autoregressive conditional heteroscedastic approach, Siami-Namini et al. (2019) demonstrated that the volatility of agricultural commodity price index and other commodities price indices overshot their long-run equilibrium in response to a shock in monetary policy. In the latest study, Kim and Kim (2021) found a 'delayed overshooting' of the US farm price under monetary policy shocks.

However, there has also been some evidence to the contrary. For instance, Tweeten (1980) asserted that an expansionary monetary policy resulted in fluctuations of flexible agricultural prices relatively lower than sticky nonfarm prices since farmers are price-takers with little ability to pass on their higher input costs to consumers. Lapp (1990) found no evidence to prove that monetary policy would determine the variation of agricultural prices in the long term. Awokuse (2005) also pointed out that monetary policy would not affect agricultural prices over the long run. Kwon and Koo (2009) asserted that the main macroeconomic shocks causing the overshooting of agricultural prices were unexpected movements of exchange rates and the interest rate.

To the best of our knowledge, most extant research on the overshooting of agricultural prices has focused on developed countries, with little attention paid to developing countries. As demonstrated by Saghaian et al. (2002a), the overshooting phenomenon could also be significant in developing countries. More importantly, the monetary policies of developing countries have a greater and longer-term impact on their economies than the policies of developed countries (Hye and Ali 2009), and the impact of money supply shocks on food prices in developing countries is likely to be long term in nature (Siddiqui and Hye 2010; Yu 2014; Li et al. 2017).

Another important fact neglected by previous studies is that some developing countries implement a fixed ERR rather than the system of flexible exchange rates assumed to prevail. Fixed exchange rates, as discussed above, would change the empirical results of overshooting to some extent. Therefore, it is of great theoretical and practical significance to test whether the absorber hypothesis of exchange rates holds under a fixed ERR and, if so, how the absorption mechanism works.

MATERIAL AND METHODS

The absorber hypothesis of exchange rates. We rely on the overshooting framework developed by Saghaian et al. (2002b) but relax the assumption of absolutely sticky industrial prices (i.e. the assumption that industrial prices are not impacted by monetary expansion). First, we assume an open economy consisting of three sectors, namely agriculture, industry, and asset market. Agricultural prices and exchange rates are assumed to be flexible and immediately responsive to monetary shocks, while industrial prices are assumed to be stickier relative to agricultural prices. This means that, under the impact of a monetary expansion, industrial prices would change at a slower pace, and to a lesser degree, than agricultural prices instead of, as in previous studies, keeping them constant. This assumption is consistent with reality, as we can observe that the movements of industrial prices relative to agricultural prices vary in a similar way but show less variation in real data generating processes (Figure 2).

Following Saghaian et al. (2002b), our theoretical framework begins with the derivative of agricultural prices with respect to money supply:

$$\frac{dp_c}{dm} = 1 - \frac{\alpha_1}{\alpha_2}\left(\frac{dp_m}{dm} - 1\right) - \frac{\left[\lambda\beta + \left(1 - \alpha_1 - \alpha_2\right)\right]}{\alpha_2}\left(\frac{de}{dm} - 1\right) \tag{1}$$

where: p_c, p_m – agricultural and industrial prices, respectively; subscripts of $_c$ and $_m$ – agricultural and industrial sectors, respectively; m – log of the domestic nominal money supply; α_1, α_2 – shares of industrial and agricultural products in the economy; $1 - \alpha_1 - \alpha_2$ – share of import goods; e – logarithm of the current exchange rate measured in units of domestic currency per unit of foreign currency, which is endogenous; λ – semi-elasticity of money demand with respect to the interest rate; $-\beta$, $(\beta > 0)$ – negative characteristic root; see Saghaian et al. (2002b) for the detailed derivation.

Under the assumption of industrial price stickiness (i.e. $dp_m/dm = 0$), Equation (1) can be easily transformed into the overshooting framework of Saghaian et al. (2002b). However, the absolute stickiness of industrial prices is inconsistent with reality, as a monetary expansion will always result in simultaneous fluctuations of both agricultural and industrial prices, although the influence on the latter is weaker. This

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finding is supported by our time-series data, as shown in Figure 2. Therefore, we relax the assumption of absolute stickiness of industrial prices and assume

$$\frac{dp_m}{dm} = c \times \frac{dp_c}{dm}, 0 < c < 1.$$

where: c – stickiness coefficient

Then, according to Equation (1), we can solve for dp_c/dm and dp_m/dm:

$$\frac{dp_c}{dm} = \frac{\alpha_1 + \alpha_2}{c \times \alpha_1 + \alpha_2} - \frac{\left[\lambda\beta + \left(1 - \alpha_1 - \alpha_2\right)\right]}{\alpha_2}\left(\frac{de}{dm} - 1\right) \tag{2}$$

$$\frac{dp_m}{dm} = \frac{c \times \left(\alpha_1 + \alpha_2\right)}{c \times \alpha_1 + \alpha_2} - \frac{c \times \left[\lambda\beta + \left(1 - \alpha_1 - \alpha_2\right)\right]}{\alpha_2}\left(\frac{de}{dm} - 1\right) \tag{3}$$

i) For a fixed ERR, we have $de/dm = 0$; then, Equations (2) and (3) can be rewritten as:

$$\frac{dp_c}{dm} = \frac{\alpha_1 + \alpha_2}{c \times \alpha_1 + \alpha_2} + \frac{\left[\lambda\beta + \left(1 - \alpha_1 - \alpha_2\right)\right]}{\alpha_2} \tag{2a}$$

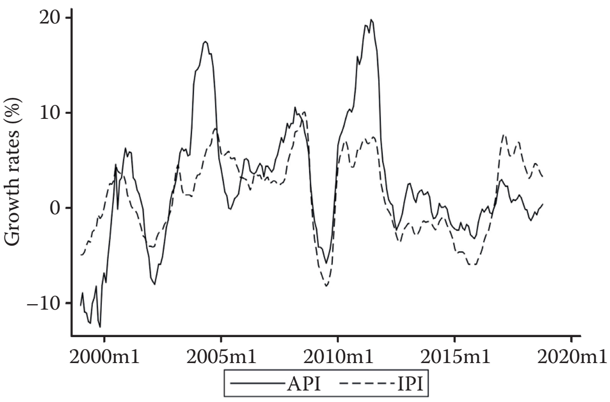

Figure 2. The fluctuation of agricultural and industrial price indices

API, IPI, and m1 – the purchase price index of agricultural products, the producer price index for industrial products, and the month identifier (i.e. January) in each year, respectively

Source: Wind Economic Database (Wind 2020)

$$\frac{dp_m}{dm} = \frac{c \times \left(\alpha_1 + \alpha_2\right)}{c \times \alpha_1 + \alpha_2} + \frac{c \times \left[\lambda\beta + \left(1 - \alpha_1 - \alpha_2\right)\right]}{\alpha_2} \tag{3a}$$

In Equation (2a), we have $dp_c/dm > 1$, since $0 < c < 1$, $0 \le \alpha_1 + \alpha_2 \le 1$, $\lambda > 0$, and $\beta > 0$. This implies the existence of overshooting agricultural prices, and the extent of overshooting is greater than for industrial prices in all situations. While dp_m/dm in Equation (3a) could be larger than, equal to, or smaller than one, it must be smaller than dp_c/dm, as assumed.

ii) Under the conditions of a floating ERR and $0 < de/dm < 1$ (i.e. undershooting of exchange rates), Equation (2) will still hold, and we also have $dp_c/dm > 1$, because the second term on the right-hand side of Equation (2) is negative. However, since the absolute value of $(de/dm) - 1$ is below one, the overshooting of agricultural prices, in this case, is weaker than in the case of a fixed ERR. Additionally, dp_m/dm is smaller than that under the fixed ERR. Theoretical results *i*) and *ii*) can be defined as the absorber effect of exchange rates and imply that floating exchange rates act as an 'absorber' that dampens the effect of monetary expansion on agricultural prices.

iii) For a floating ERR and $de/dm = 1$, Equations (2) and (3) can be simplified as:

$$\frac{dp_c}{dm} = \frac{\alpha_1 + \alpha_2}{c \times \alpha_1 + \alpha_2} \tag{2b}$$

$$\frac{dp_m}{dm} = \frac{c \times \left(\alpha_1 + \alpha_2\right)}{c \times \alpha_1 + \alpha_2} \tag{3b}$$

where: dp_c/dm – still larger than one, and the overshooting of agricultural prices also exists, but its extent is weaker than in *i*) and *ii*); meanwhile, $dp_m/dm < 1$ indicates that industrial prices will slightly undershoot their long-run equilibrium value.

iv) Under floating exchange rates and $de/dm > 1$ (i.e. overshooting of exchange rates), dp_c/dm could be greater than, equal to, or less than one depending on the trade-off between the two terms on the right-hand side of Equation (2). While dp_m/dm is definitely less than one since it equals

$$\frac{c \times \left(\alpha_1 + \alpha_2\right)}{c \times \alpha_1 + \alpha_2}$$

(less than one), subtracting a positive term yields

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$$\frac{\left[\lambda\beta+\left(1-\alpha_1-\alpha_2\right)\right]}{\alpha_2}\left(\frac{de}{dm}-1\right).$$

Data. The data used in this paper include the purchase price index of agricultural products (API_t, t is the subscript of the month), producer price index for industrial products (IPI_t), exchange rates growth (EXR_t), and money supply (measured by M1, i.e. the cash in circulation plus current deposit of enterprises) growth rate ($M1_t$). All data were obtained from the Wind Economic Database (Wind 2020), a commercial database widely used in China. The summary statistics for these variables are reported in Table 1, which shows that the M1 growth rate has the largest fluctuation, with a mean annual growth rate of 14.78% and a maximum of 38.96%. This reflects China's expansionary monetary policy over the past two decades, especially the first decade of the 21st century (as shown in Figure 1). Exchange rates, however, fluctuated little relative to M1. The mean EXR_t during the entire sample period was only 1.24%, and almost zero before 2005 under the fixed ERR.

Table 1. Summary statistics for the key variables (%), n = 238

Variable	Mean	SD	Min	Max
API_t	2.538	6.627	–12.500	19.800
IPI_t	1.332	4.264	–8.200	10.100
EXR_t	1.242	3.481	–8.397	10.865
$M1_t$	14.777	6.809	1.200	38.960

API_t, IPI_t, EXR_t, and $M1_t$ – the purchase price index of agricultural products, the producer price index for industrial products, the exchange rates growth, and the money supply growth rate, respectively

Source: Wind Economic Database (Wind 2020)

As shown in the first two rows of Table 1, the API average annual growth rate is 2.5% or about twice as large as that of the IPI. The API growth rate reached its peak of 20% in June 2011, which was nearly twice the maximum of the IPI. Figure 2 depicts the API and IPI trends, which show a similar pattern during the sample period, but the API variations were more flexible than those of the IPI. Severe fluctuations of agricultural prices in China were witnessed in the 2000s and early 2010s. For instance, the API soared to a historic high level of nearly 20% in both 2004 and 2011. While in 2000, 2002, and 2009, agricultural prices in China experienced dramatic drops, as the API was less than –5% for each year. China has the largest agricultural markets, producers, and consumers in the world; therefore, extreme fluctuations of agricultural prices would inevitably draw significant attention from the government and the public. Investigating the formation mechanism of severe fluctuations of agricultural prices in terms of overshooting has both theoretical and practical significance and is the main motivation of our study.

RESULTS AND DISCUSSION

Testing the overshooting mechanism of agricultural prices. It is well known that performing a regression with nonstationary time series through the ordinary least squares (OLS) method would probably result in spurious results. Therefore, we apply the Dickey-Fuller generalised least squares (DF-GLS) method to test the stationarity of key variables. The Stata 15 software was used to perform all empirical analyses and generate all graphs in this study.

As shown in Table 2, all four key variables are nonstationary but integrated of order one. As such, we cannot test their relationship using the OLS approach. Alternative analysis tools, such as the framework

Table 2. Test results for unit roots

Statistics	API_t	IPI_t	EXR_t	$M1_t$
Test results for variables in levels				
DF-GLS tau statistic	–1.766	–2.277	–1.903	–2.334
Test results for variables after first-differencing				
DF-GLS tau statistic	–3.685***	–4.073***	–4.073***	–2.822**
Integration order	I(1)	I(1)	I(1)	I(1)

**, ***Rejections for the null hypotheses of no unit roots at the 5% and 1% levels, respectively; DF-GLS – Dickey-Fuller generalised least squares; API_t, IPI_t, EXR_t, and $M1_t$ – the purchase price index of agricultural products, the producer price index for industrial products, exchange rates growth, and money supply growth rate, respectively

The Stata package will compute the Maxlag automatically through the Schwert criterion, i.e. $P_{max}=\left[12\times\left(T/100\right)^{1/4}\right]$, where: T – sample size and brackets means taking an integer (Schwert 1989)

Source: Own calculations based on Wind Economic Database (Wind 2020)

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of cointegration developed by Johansen (1991) and the corresponding vector error correction model (VECM), have been demonstrated to be effective for testing the overshooting hypothesis in previous studies (Robertson and Orden 1990; Lai et al. 1996; Saghaian et al. 2002a, 2002b). Since all criteria suggest a second-order lag for the vector autoregression (VAR) model [see the electronic supplementary material (ESM) of Table S1 for the results; for the ESM see the electronic version], we test the cointegration rank based on a second lagged VAR framework. As shown in Table 3, the trace statistic is 14.843, indicating two cointegration relationships between the investigated time series.

The estimated coefficients for θ_1 and θ_2 in Table 4 are 5.466 and 0.154, respectively, both statistically significant at least at the 10% level. The large difference in values means that a 1% increase in the money supply will lead to agricultural and industrial price increases of 5.466% and 0.154%, respectively, on average and *ceteris paribus*. These results depict the long-run equilibrium relationship between the four variables and are consistent with the theoretical overshooting hypothesis since the impact of monetary expansion on flexible agricultural prices is significantly larger than on sticky industrial prices. Meanwhile, these results also reject the long-run neutrality hypothesis of money and so confirm the theoretical results of previous studies (Frankel 1986; Lai et al. 1996). Our results are consistent with the findings of some recent studies, e.g. Robertson and Orden (1990) and Saghaian et al. (2002b) verified a departure from money neutrality in the case of New Zealand and the US, respectively. Siami-Namini et al. (2019) employed a monthly dataset and also demonstrated that the US agricultural prices overshot their long-run equilibrium in response to monetary policy variation.

The empirical estimates for the VECM are presented in Table 5. As shown in the first columns, the estimation results of λ_{11} and λ_{22} are –0.005 and –0.045, re-

Table 3. Johansen test results for cointegration ranks

Null hypothesis	Eigen value	Trace statistic	5% critical value
$r = 0$	N.A.	94.646	54.640
$r \leq 1$	0.207	39.999	34.550
$r \leq 2$	0.097	16.019*	18.170
$r \leq 3$	0.042	5.923	3.740

*indicates that the trace statistic fails to reject the null hypothesis of $r \leq 2$; r – cointegrating rank

Source: Own calculations based on Wind Economic Database (Wind 2020)

Table 4. Estimation results for normalised cointegrating vectors

Variable	$\tilde{\varepsilon}_{1t-1}$	$\tilde{\varepsilon}_{2t-1}$
API_t	1	0
IPI_t	0	1
EXR_t	6.070** (2.458)	–0.079 (0.151)
$M1_t$	–5.466*** (1.401)	–0.154* (0.086)
Constant	66.925 (–)	1.228 (–)

*, **, and ***significance at the 10%, 5%, and 1% levels, respectively; standard errors (SE) are presented in the parentheses; API_t, IPI_t, EXR_t, and $M1_t$ – the purchase price index of agricultural products, the producer price index for industrial products, the exchange rates growth, and the money supply growth rate, respectively; $\tilde{\varepsilon}_{1t-1}$ and $\tilde{\varepsilon}_{2t-1}$ – one-period lagged 'disequilibrium residuals' from the respective cointegrating equations

Source: Own calculations based on Wind Economic Database (Wind 2020)

Table 5. Estimation results for the vector error correction model (VECM)

Variable	ΔAPI_t	ΔIPI_t	ΔEXR_t	$\Delta M1_t$
$\tilde{\varepsilon}_{1t-1}$	–0.005** (0.002)	–0.002** (0.001)	–0.004*** (0.001)	0.006* (0.004)
$\tilde{\varepsilon}_{2t-1}$	–0.042** (0.021)	–0.045*** (0.010)	0.020* (0.011)	–0.217*** (0.038)
ΔAPI_t	0.314*** (0.068)	0.032 (0.033)	–0.016 (0.035)	0.106 (0.122)
ΔIPI_t	0.177 (0.109)	0.651*** (0.053)	–0.035 (0.057)	0.049 (0.197)
ΔEXR_t	0.075 (0.104)	0.061 (0.050)	0.552*** (0.054)	–0.130 (0.187)
$\Delta M1_t$	–0.030 (0.036)	–0.013 (0.017)	–0.019 (0.019)	–0.301*** (0.065)
R^2	0.269	0.610	0.389	0.168

*, **, and ***significance at the 10%, 5%, and 1% levels, respectively; standard errors (SE) are presented in the parentheses; ΔAPI_t, ΔIPI_t, ΔEXR_t, and $\Delta M1_t$ – the first-differences of the purchase price index of agricultural products, of the producer price index for industrial products, of the exchange rates growth, and of the money supply growth rate, respectively; the subscript of $_{t-1}$ – one-period lagged term; $\tilde{\varepsilon}_{1t-1}$ and $\tilde{\varepsilon}_{2t-1}$ – one-period lagged 'disequilibrium residuals' from the respective cointegrating equations; R^2 – indicator of goodness of fit

Source: Own calculations based on Wind Economic Database (Wind 2020)

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spectively, both statistically significant at the 5% level. These results are also consistent with the theoretical hypothesis, meaning that a negative effect will be generated to restore equilibrium after a short-term positive departure of agricultural and industrial prices from their long-run relationship to the money supply. Our findings are very similar to those of Saghaian et al. (2002b), who also obtained negative estimated values for these two parameters in the case of the US.

In a departure from previous studies, prior to the empirical analysis of the overshooting effect, this study applied Granger causality analysis to examine the causal relationship between the four-time series. The aim is to confirm that the relationship between exchange rates and price fluctuations is causal, rather than just a simple correlation over time. As pointed out by Saghaian et al. (2002a), the error correction model was essentially a first-order difference cointegration model, where cointegration describes a long-term, stable, equilibrium relationship between different variables, and cannot prove that any fluctuation in commodity prices is caused by a monetary expansion. The monetarist school claimed that changes in the money supply could lead to fluctuations in commodity prices. Moreover, the theoretical derivations of Frankel (1986) and Saghaian et al. (2002a) indicated an overshooting effect in agricultural prices, regardless of whether the money was neutral. However, price is a complex variable, affected by monetary policy or changes in price, income, and the supply and demand of substitutes or complementary products. Therefore, it is necessary to conduct a Granger causality test to first confirm that monetary expansion is the cause of commodity price fluctuations and then perform the corresponding error correction and impulse response analysis.

The results shown in Table 6 significantly reject the null hypotheses that $M1_t$ does not Granger-cause API_t, and $M1_t$ does not Granger-cause IPI_t, as indicated in the third row of equation API_t and equation IPI_t. These test results coincide with the overshooting mechanism explained above and provide solid empirical evidence for the hypothesis. In summary, the results significantly indicate the overshooting effect of China's agricultural prices relative to industrial prices under the shock of monetary expansion. This is consistent with the reality of China, as depicted both in Table 1 and Figure 2 that API fluctuates more than IPI. In other words, the remarkable gap between API and IPI in Figure 2 is more likely to be induced by the overshooting mechanism rather than the supply and demand relationship. The policy implication is that decision-makers should pay extra attention to the spillover effects of monetary expansion, not only the macroeconomy itself.

Table 6. Granger causality tests for the pairwise variables

Equation	Excluded	Chi2	*df*	Prob. > chi2
API_t	IPI_t	1.757	2	0.415
API_t	EXR_t	2.617	2	0.270
API_t	$M1_t$	18.021	2	0.000
API_t	ALL	27.434	6	0.000
IPI_t	API_t	1.671	2	0.434
IPI_t	EXR_t	1.113	2	0.573
IPI_t	$M1_t$	10.946	2	0.004
IPI_t	ALL	18.165	6	0.006
EXR_t	API_t	1.844	2	0.398
EXR_t	IPI_t	1.971	2	0.373
EXR_t	$M1_t$	2.045	2	0.360
EXR_t	ALL	10.823	6	0.094
$M1_t$	API_t	0.457	2	0.796
$M1_t$	IPI_t	20.002	2	0.000
$M1_t$	EXR_t	0.295	2	0.863
$M1_t$	ALL	33.881	6	0.000

API_t, IPI_t, EXR_t, and $M1_t$ – the purchase price index of agricultural products, the producer price index for industrial products, the exchange rates growth, and the money supply growth rate, respectively; ALL – all the three excluded variables, IPI_t, EXR_t, and $M1_t$

Source: Own calculations based on Wind Economic Database (Wind 2020)

Testing the effects of the ERR reform on overshooting. To examine the effects of the ERR reform on the overshooting mechanism, we partition the sample into two subsamples according to the time of reform implementation (July 2005). We then use the impulse response function (IRF) for comparative testing.

Figure 3 depicts the dynamic responses of agricultural and industrial prices to the impulse in monetary supply. As shown, a one-unit innovation in monetary supply shock will cause increases in both agricultural and industrial prices that disappear after around 30 months. There are two noteworthy features of these two dynamic IRF curves. One is their different heights: the IRF of monetary supply shock of agricultural prices is obviously higher than that of industrial prices over the entire dynamic process. This characteristic strongly supports the overshooting hypothesis of agricultural prices relative to industrial prices under the shock of monetary supply. The other feature is that the dynamic trends of both IRF curves show significant inverted-U shapes, which peak after 11 months

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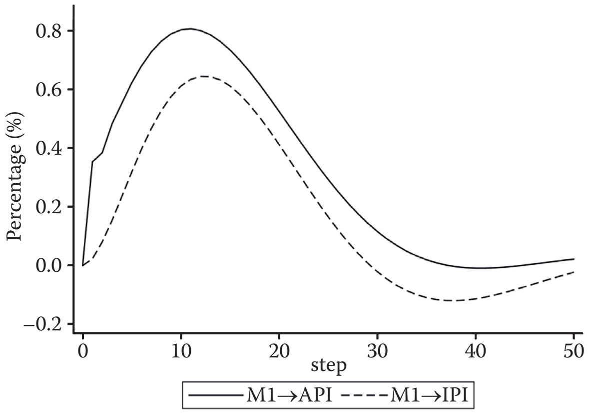

Figure 3. Orthogonalised IRFs for both API and IPI during the whole sample period

IRF – impulse response function; API and IPI – the purchase price index of agricultural products and the producer price index for industrial products, respectively; M1 – the money supply growth rate

Source: Own calculations based on Wind Economic Database (Wind 2020)

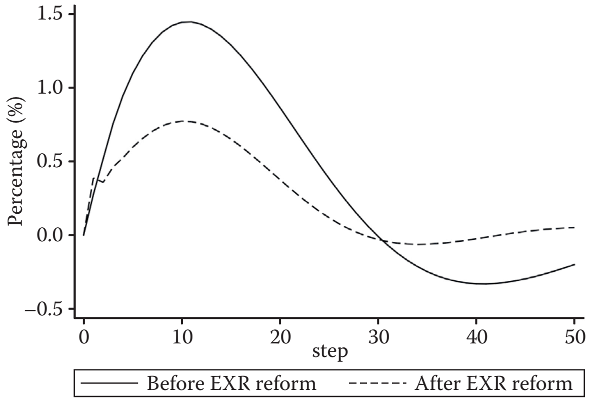

Figure 4. Orthogonalised IRFs for API before and after the EXR reform

IRF – impulse response function; API – the purchase price index of agricultural products and the producer price index for industrial products; EXR – exchange rate regime

Source: Own calculations based on Wind Economic Database (Wind 2020)

or 12 months. This is evidence in support of the lagged effect of monetary policy, as contended in mainstream macroeconomics.

Figures 4 and 5 depict the orthogonalised IRFs of the monetary supply shock on agricultural and industrial prices before and after the ERR reform, respectively. Both figures show similar dynamic patterns to those in Figure 3, revealing that the monetary supply shock has a positive effect on agricultural and industrial prices, both before and after the reform. The most important point is the significant difference between the two IRF curves in Figure 4. Specifically, the solid line (pre-reform IRF) is much higher than the dotted line (post-reform IRF), while there is no such difference for the IRF of industrial prices, as shown in Figure 5. These results strongly confirm the theoretical prediction above that the overshooting effect of agricultural price under a fixed ERR is greater than that under a floating ERR. Under a fixed ERR, the shock from the monetary expansion is largely absorbed by the flexible-price sector, thus resulting in a sharp fluctuation of agricultural prices. However, after ERR reform, floating exchange rates share part of the shock from the monetary expansion, in accordance with the 'absorber' hypothesis propounded in the literature. Figure 5 indicates that whether exchange rates are fixed or floating makes no difference to the response of the industrial price index with respect to the monetary expansion impulse. This is probably due to the relatively fixed nature of industrial prices.

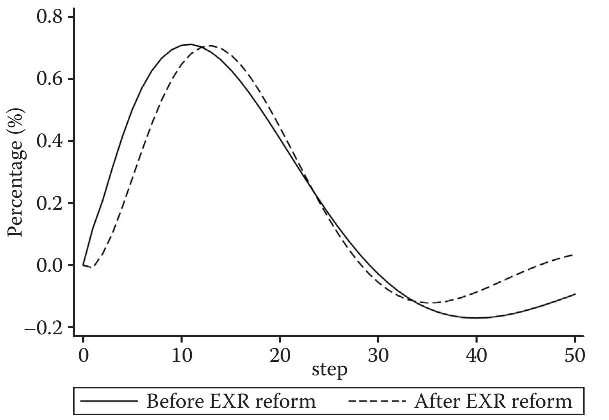

Figure 5. Orthogonalised IRFs for IPI before and after the EXR reform

IRF – impulse response function; IPI – the producer price index for industrial products; EXR – exchange rate regime

Source: Own calculations based on Wind Economic Database (Wind 2020)

CONCLUSION

Using modern time series methods, we demonstrate the overshooting of agricultural prices in China since the impact of the monetary expansion on flexible agricultural prices is significantly larger than that on sticky industrial prices. The results also reject the long-run neutrality hypothesis of money, as contended in some previous studies. Granger causality tests confirm that monetary expansion is a possible cause

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of agricultural and industrial price movements, which provides solid empirical evidence for the overshooting hypothesis. The empirical results also strongly confirm the absorber hypothesis, in that the overshooting effect of agricultural prices under a fixed ERR is greater than that under a floating ERR.

The main contributions of this study are twofold. First, it extends the overshooting model by relaxing the absolute stickiness assumption of industrial prices. Second, it tests the absorber hypothesis of exchange rates for the overshooting of agricultural prices in China using monthly aggregate data. Our augmented framework provides insight for future research investigating the role of the ERR on the relationship between the macroeconomy and agricultural prices. The empirical findings of this study also have a significant policy implication. Public decision-makers, especially those in macroeconomic and agricultural sectors, should pay attention to the spillover effects of monetary policy and exchange rate on agricultural prices, especially for a fixed ERR.

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